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(19) Japanese Patent Office (JP)

(11) Laid Open Patent Application Publication No.

(12) **Laid Open Patent Application Publication (A)** P2003-234513A

(43) Publication Date: August 22, 2003

(51) Int. Cl.[7]	Identification Symbols	FI	Theme Codes (for references)
H01L 33/00		H01L 33/00 N	5F041
		C	

Examination Request: Requested

Number of Claims: 1 document (Total of 3 pages)

(21)	Patent Application No.:	P2003-67318
(62)	Indication of Division:	Division of P2001-313286
(22)	Application Date:	November 25, 1991
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F Terms (for references)		5F041 AA11 AA14 CA40 CA46 DA16 DA43 DA55 DB01 EE25

(54) [Invention Title] Resin for Wavelength-Variable Light Emitting Diodes to which a Fluorescent Dye or Pigment is Added

(57) [Abstract]

[Issue] To improve the luminosity factor and brightness of an LED having a light emission device which is made of gallium nitride related compound semiconductor materials.

[Resolution Means] A resin for wavelength-variable light emitting diodes to which a fluorescent dye or pigment is added for converting light from a light emitting device ~~which~~ is named of stacked n-type and p-type gallium nitride related compound semiconductor materials; wherein the fluorescent dye or pigment in said resin for wavelength-variable light emitting diode is excited with blue visible light from the light emitting device, and emits visible light with wavelengths longer than those of the excitation light, thereby improving the luminosity factor of the light emitting diodes.

[What is Claimed is:]

[Claim 1] A resin for wavelength-variable light emitting diodes to which a fluorescent dye or pigment is added for converting light from a light emitting device which is named of stacked n-type and p-type gallium nitride related compound semiconductor materials;

wherein the fluorescent dye or pigment in said resin for wavelength-variable light emitting diode is excited with blue visible light from the light emitting device, and emits visible light with wavelengths longer than those of the excitation light, thereby improving the luminosity factor of the light emitting diodes.

[Detailed Explanation of Invention]

[0001]

[Field of Industrial Application]

The present invention relates to a light emitting diode (hereafter referred to as an LED) in which a light emitting device is surrounded with a resin mold. In particular, the present invention relates to a light emitting diode which can emit a variety of light emissions using one type of light emitting device, further which is bright, and which can vary the emission wavelength.

[0002]

[Conventional Technologies]

In general, an LED has a structure as illustrated in Figure 1. The numeral designator 1 represents a light emitting device which is cut to a piece of 1mm square or smaller and which is made of materials such as GaAlAs and GaP, the numeral designator 2 represents a metal stem, the numeral designator 3 represents a metal post and the numeral designator 4 represents a resin mold which surrounds the light emitting device. The back surface electrode of the light emitting device 1 is attached on the metal stem 2 using a material such as silver paste, thereby electrically connecting it thereto. A gold wire coming from the metal post 3, which is the other electrode, is bonded to the surface of the front surface electrode of the light emitting device 1. Further, the light emitting device 1 is molded using the transparent resin mold 4.

[0003]

Ordinarily, a resin with a large index of refraction and a high transparency is selected for the resin mold 4, so that the emission light from the light emitting device is efficiently emitted to the air. In other cases, an inorganic or organic pigment is mixed as a coloring agent in the resin mold 4 in order to convert or correct the emission color of the light emitting device. For instance, when a red pigment is added to a resin mold around a green light emitting device having GaP semiconductor materials, its emission color turns into white.

[0004]

[Issues to be Resolved by Invention]

Conventionally, however, most of technologies to convert the wavelength by adding a coloring agent to a resin mold are not put into practical use and only handful technologies to employ a coloring agent for color correction are utilized. This is because adding an enough amount of a coloring agent, which is a non-light-emission material, to realize the wavelength conversion greatly reduces the brightness of an LED.

[0005]

In addition, currently realized LED's are infrared, red, yellow and green light emitting ones. Blue and ultraviolet LED's are not yet realized. Research is being conducting with semiconductors such as ZnSe which is a II-VI group material, SiC which is a IV-IV group material, and GaN which is a III-V group material. Recently, among these materials, gallium nitride related compound semiconductors which are expressed with a general formula of $Ga_XAl_{1-X}N$ (where $0 \leq X \leq 1$) are attracting attentions because it was found that they exhibit relatively superior light emission at normal temperatures. Moreover, LED's employing gallium nitride related compound semiconductors in which a pn junction was realized for the first time were reported (Oyo Butsuri, vol. 60, No. 2, pp163-166, 1991). According to this publication, LED's employing gallium nitride related compound semiconductors have a main emission peak at around 430nm and also have another emission peak in the ultraviolet range of around 370nm. These wavelengths are the shortest among those for the above semiconductor materials. Such LED's, however, have a disadvantage in that their luminosity factor is poor because the emission color is close to violet, as their emission wavelength indicates.

[0006]

The present invention was conceived with considerations being given to such circumstances. Its purpose is to improve the luminosity factor and brightness of LED's having a light emission device which is made of gallium nitride related compound semiconductors whose emission peaks are in the vicinities of 430nm and 370nm.

[0007]

[Means to Resolve Issues]

The present invention provides a resin for wavelength-variable light emitting diodes to which a fluorescent dye or pigment is added for converting light from a light emitting device which is named of stacked n-type and p-type gallium nitride related compound semiconductor materials; wherein the fluorescent dye or pigment in said resin for wavelength-variable light emitting diode is excited with blue visible light from the light

emitting device, and emits visible light with wavelengths longer than those of the excitation light, thereby improving the luminosity factor of the light emitting diodes.

[0008]

[Embodiment to Implement Invention]

Figure 2 illustrate an example to depict the structure of an LED according to the present invention. The numeral designator 11 represents a blue light emitting device in which n-type and p-type GaAlN layers are stacked on a sapphire substrate, the numeral designators 2 and 3 represent a metal stem and a metal post, respectively, in the same manner as in Figure 1, and the numeral designator 4 represents a resin mold surrounding the light emitting device. There is the sapphire insulating substrate on the back surface of the light emitting device 11 and an electrode can not be made on the back surface. Therefore, in order to electrically connect an n-electrode on the GaAlN layer to the metal stem 2, a method is employed in which the GaAlN layers are etched to expose the surface of the n-type layer, upon which an ohmic electrode is attached. The ohmic electrode and the metal stem 2 are electrically connected using a gold wire. Moreover, the other electrode is wire-bonded to the surface of the p-type layer using a gold wire coming from the metal post 3 in the same manner as in Figure 1. Further, a fluorescent dye 5 which is excited with light with a wavelength near 420 to 440nm and which emits light with an emission peak near 480nm is added to the resin mold 4.

[0009]

[Advantages of Invention]

A fluorescent dye or pigment is generally excited with a short-wavelength light and emits light with a longer wavelength than that of the excitation light. Contrarily, there are fluorescent pigments which are excited with a long-wavelength light and which emit light with a shorter wavelength than that of the excitation light. Such materials, however, have a very poor energy efficiency and provides a very week emission light. As discussed above, gallium nitride related compound semiconductors have emission peaks in the shortest wavelength range among semiconductor materials which are employed for LED's. Moreover, they have an emission peak in the ultraviolet range. Therefore, when they are employed as materials for a light emitting device and when a fluorescent dye or pigment is added to a resin mold surrounding the light emitting device, the fluorescent material can be most optimally excited. Therefore, different types of a fluorescent dye or pigment can not only correct color of blue LED's but also convert light into a variety of wavelengths. Further, light with a shorter wavelength is converted to one with a longer wavelength with a good energy efficiency and hence, the amount of a fluorescent dye or pigment can be small and the invention is very excellent from the view point of reducing the degradation of luminosity factor.

[Brief Explanation of Figures]

[Figure 1] A schematic cross section to illustrate the structure of a conventional LED.

[Figure 2] A schematic cross section to illustrate the structure of an example of an LED according to the present invention.

[Explanation of Numeral Designators]

11 Light emitting device

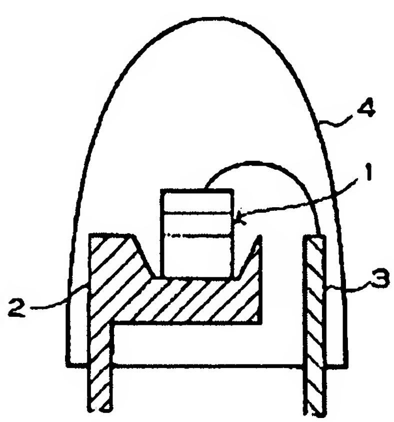
2 Metal stem

3 Metal post

4 Resin mold

5 Fluorescent dye

[Figure 1]



[Figure 2]